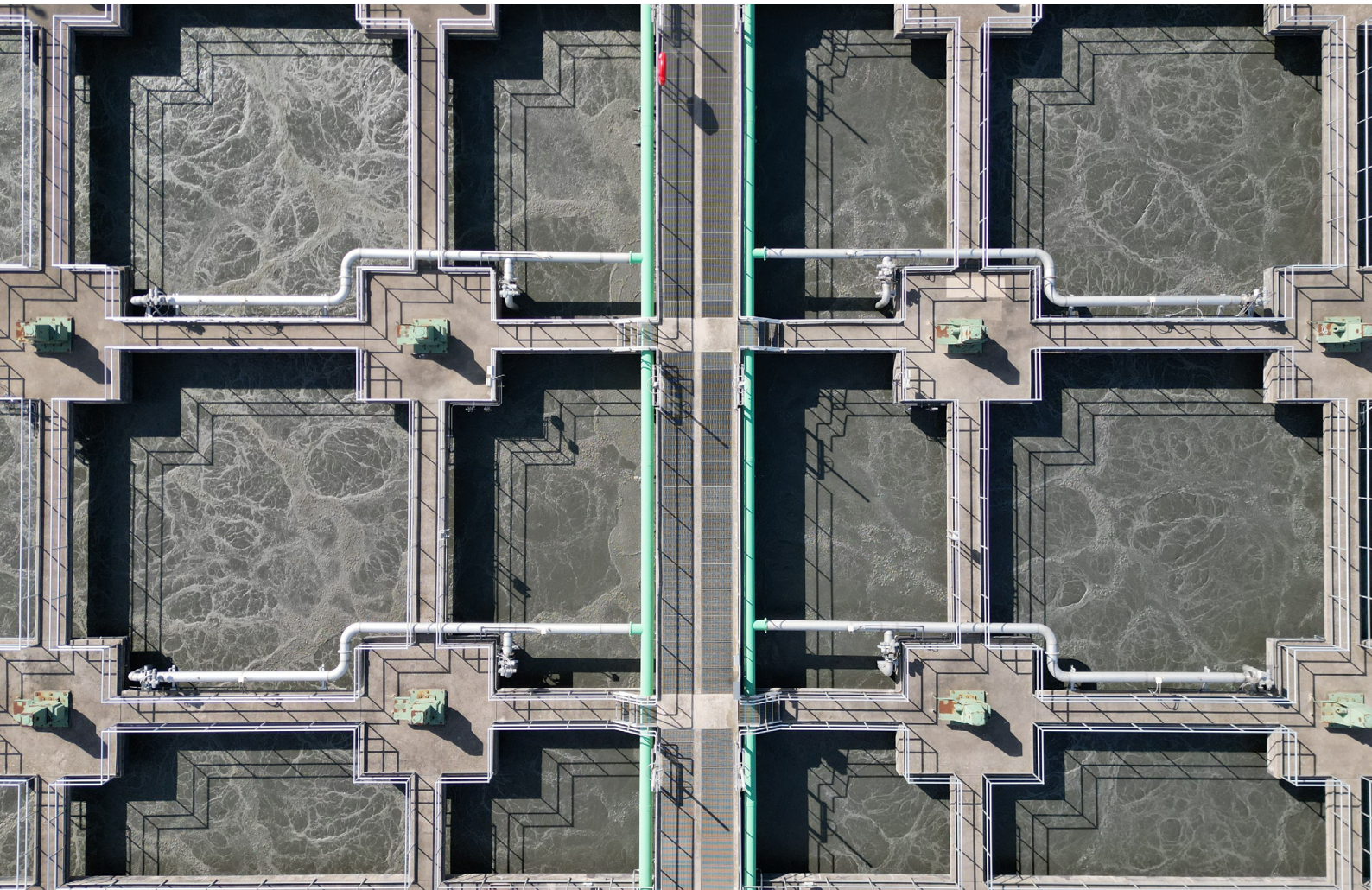




UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Bureau
International des
Poids et
Mesures



Metrology for Reliable Transport and Suitability of Potable Water in Brazil

INMETRO is developing new measurement services through CRMs and PT schemes for determining water turbidity and pipe hardness to ensure potable water for all

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The Challenge

To be considered potable, that is, “safe and clean”, and suitable for consumption, water must meet specific parameters to be considered free of potentially harmful pathogens. One important parameter is the turbidity index, an indicator of water clarity or, conversely, water cloudiness caused by the presence of suspended matter (e.g., algae, sediments, other physical contaminants). Turbidity levels are typically measured using digital turbidimeters, which display the reading in Nephelometric Turbidity Units (NTU). This parameter is associated with the interaction between visible radiation and any contaminants present in the water. To ensure water is potable, it is essential to have reliable measurement equipment to determine turbidity levels. One way to ensure the validity of the results is to use Certified Reference Materials (CRMs) to check the performance of the turbidimeters used in routine testing. Metrology, applied to the development of standardization methodologies and CRMs for turbidity, is fundamental to ensuring access to potable water for the population.

The mechanism for delivering potable water is also of paramount concern. A study analyzing the environmental, economic, and social impacts of inefficient water loss control in Brazil indicates that the volume of water wasted in the country would be sufficient to supply approximately 77 million people. The volume lost is more than double the number of Brazilians without access to water, estimated at around 33 million people. One reason for the inefficiency of the supply process is pipeline leaks.¹

To prevent such leaks, plastic pipes for potable water conveyance must withstand sufficient pressure to be suitable and durable. Mechanical strength is a fundamental property for piping used in the proper transport of potable water. The Shore hardness test is a destructive test that evaluates a material's resistance to penetration by an indenter of known dimensions, pressed against the material's surface with a known force. The indentation resistance measured in Shore hardness units is directly related to the mechanical strength of the plastic materials commonly used to convey potable water. An advantage of the Shore hardness test over other mechanical tests is its versatility, as it does not require standardized sample dimensions to evaluate or characterize a material's mechanical strength. Thus, it can be applied to plastic pipes of various sizes and shapes. Shore hardness also allows assessment of mechanical strength through direct measurement on the product itself, thereby enabling

¹ Ullah Riaz, et al, Water Quality Index and Human Health Risk Assessment of Drinking Water in Selected Urban Areas of a Mega City, *Toxics*, 2023, <https://doi.org/10.3390/toxics11070577>

industrial quality control of intact manufactured piping for using in its present condition within a water distribution system.

The Solution

For use in validation and quality assurance, Certified Reference Materials (CRMs) can serve as a basis for ensuring the metrological validity and reliability of test results across a range of measurement processes. CRMs can also be used as calibrators to ensure the metrological traceability to the measurement systems or equipment used in the daily operations of universities, research centers, and industries.

INMETRO is planning to develop a CRM for the turbidity index, which will be produced based on the known concentration of a specific substance in an aqueous solution. Concentration can be determined using metrologically traceable measurements of the mass and volume of a given solution. This measurand will provide a measure for the “turbidity” index and serve as a reference for analysis by testing equipment. This will allow for the application of the necessary correction between the turbidity value indicated by the equipment and the reference value derived from the CRM. The proposed development of CRM for turbidity index as the metrological solution is presented in **Figure 1**.

Developing quality infrastructure encompassing reliable Shore hardness measurements for plastic materials and the production of CRMs to ensure metrological reliability is also fundamental to enabling the production of more resistant and durable plastic piping for water transport. The proposal for developing a CRM for Shore hardness as the metrological solution for plastic materials used in potable water transport is shown in **Figure 2**.

Shore hardness testing is standardized under ISO 48-4 *Rubber, vulcanized or thermoplastic — Determination of hardness — Part 4: Indentation hardness by durometer method (Shore hardness)* and ASTM D2240 *Standard Test Method for Rubber Property—Durometer Hardness for rubber and plastic materials*. The documentary standard ISO 48-4 covers thermoplastic rubbers, while the ASTM D2240 standard is widely used in the United States, as it is applicable to a broader range of polymeric materials. The aforementioned standards will serve as the starting points for the development of CRMs and the production of a Brazilian standard for Shore hardness.^{2,3}

² CNN News article. “Total de desperdício de água no Brasil poderia abastecer 77 milhões”

<https://www.cnnbrasil.com.br/nacional/brasil/total-de-desperdicio-de-agua-no-brasil-poderia-abastecer-77-milhoes/>

³ GM/MS Ordinance No. 888, of May 4, 2021 – Amends Annex 20th of GM/MS Consolidation -Ordinance No. 5, of September 28, 2017-, to establish procedures for the control and surveillance of water quality for human consumption and its Brazilian potability standards.

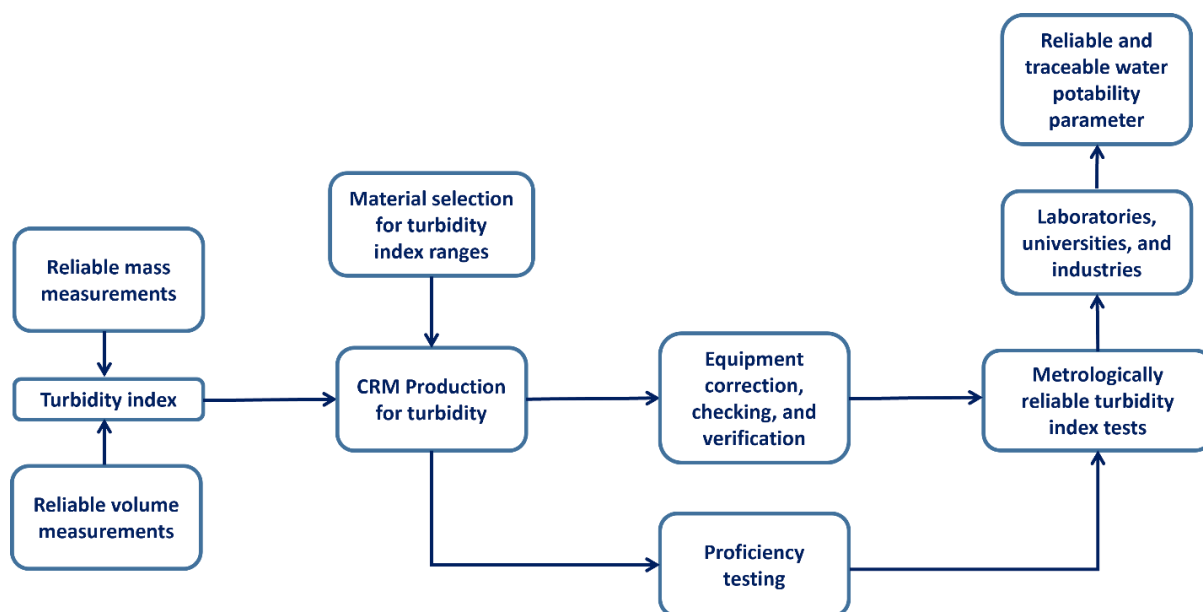


Figure 1. A scheme depicting Inmetro’s development plan for CRM for turbidity to increase the metrological reliability of turbidity index measurements

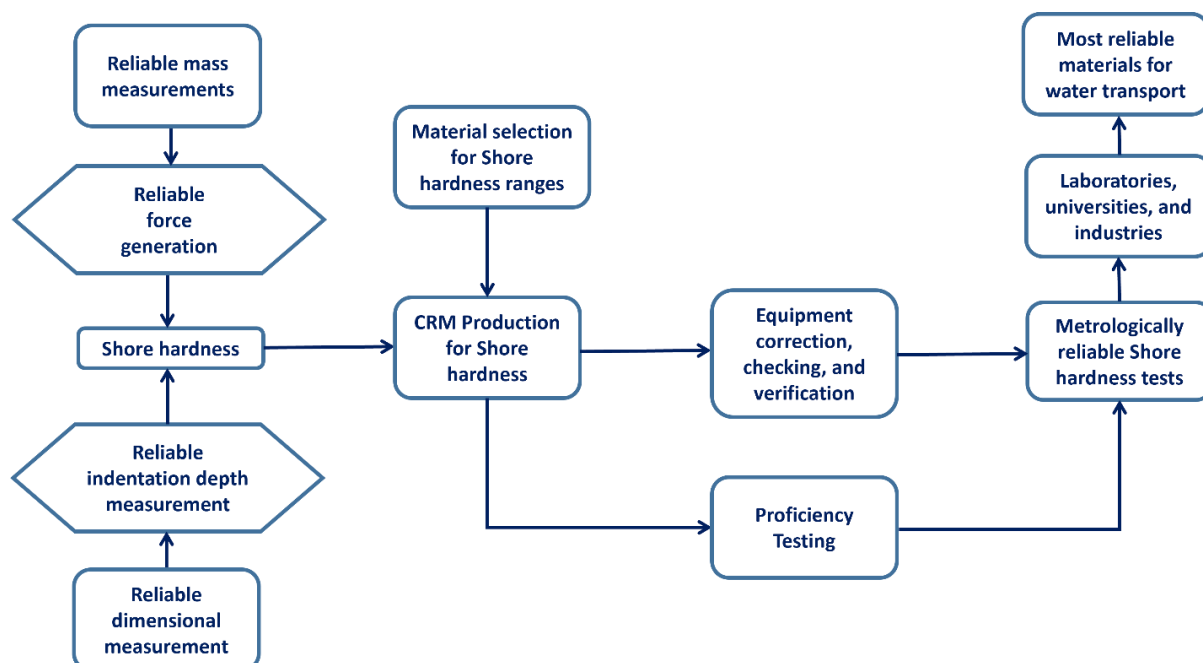


Figure 2. A scheme depicting Inmetro’s development plan for a CRM for Shore hardness to increase the metrological reliability of material hardness properties for potable water infrastructure.

A Quantifiable Impact

Guaranteeing the validity of the results will be fundamental to ensuring access to potable water and reducing the incidence of diseases caused by the consumption of unsafe water. Inmetro's planned provision of measurement services involves the characterization, production and distribution of CRMs for hardness to testing laboratories, and other stakeholders, has now become a normal practice in the water testing community within Brazil. Guaranteeing the validity of testing results for routine water distribution pipe materials can improve product quality, ensuring potable water without waste in a lasting way.

INMETRO plans to carry out a proficiency testing (PT) scheme to support testing laboratories in the determination of water turbidity indices. The turbidity index is an important metric of water quality that must be determined accurately; an increase in water turbidity directly raises the operating costs of treatment plants due to higher consumption of chemical inputs, such as coagulants. Research indicates that a 1 % increase in raw water turbidity at the source raises treatment costs by approximately 0.12 %.⁴ Wastage of potable water is also increasing in Brazil, with losses exceeding USD 2 billion annually; in 2016, this amounted to 38 % of the potable water produced within distribution systems—equivalent to nearly 7 000 full Olympic-sized swimming pools every day.⁵

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⁴ Indicadores de Qualidade - Índice de Qualidade das Águas (IQA). <https://www.ana.gov.br/portalnqa/indicadores-indice-aguas.aspx>

⁵ Economia, "Desperdício de água potável aumenta no Brasil, e perdas chegam a mais de R\$ 10 bilhões ao ano, aponta estudo" <https://g1.globo.com/economia/noticia/desperdicio-de-agua-potavel-aumenta-no-brasil-e-perdas-chegam-a-mais-de-r-10-bilhoes-ao-ano-aponta-estudo.ghtml>